

Altimeter Meeting, Invited Paper

The Precise Orbit and the Challenge of Long Term Stability

F. G. Lemoine (1), Luca Cerri (2), Michiel Otten (3), William I. Bertiger (4), Nikita P. Zelensky (5,1), Pascal Willis (6)

The computation of a precise orbit reference is a fundamental component of the altimetric measurement. Since the dawn of the modern altimeter age, orbit accuracy has been determined by the quality of the GPS, SLR, and DORIS tracking systems, the fidelity of the measurement and force models, and the choice of parameterization for the orbit solutions, and whether a dynamic or a reduced-dynamic strategy is used to calculate the orbits. At the start of the TOPEX mission, the inaccuracies in the modeling of static gravity, dynamic ocean tides, and the nonconservative forces dominated the orbit error budget. Much of the error due to dynamic mismodeling can be compensated by reduced-dynamic tracking techniques depending on the measurement system strength. In the last decade, the launch of the GRACE mission has eliminated the static gravity field as a concern, and the background force models and the terrestrial reference frame have been systematically refined. GPS systems have realized many improvements, including better modeling of the forces on the GPS spacecraft, large increases in the ground tracking network, and improved modeling of the GPS measurements. DORIS systems have achieved improvements through the use of new antennae, more stable monumentation, and of satellite receivers that can track multiple beacons, and as well as through improved modeling of the nonconservative forces. Many of these improvements have been applied in the new reprocessed time series of orbits produced for the ERS satellites, Envisat, TOPEX/Poseidon and the Jason satellites, and as well as for the most recent Cryosat-2 and HY2A.

We now face the challenge of maintaining a stable orbit reference for these altimetric satellites. Changes in the time-variable gravity field of the Earth and how these are modelled have been shown to affect the orbit evolution, and the calibration of the altimetric data with tide gauges. The accuracy of the reference frame realizations, and their projection into the future remains a source of error. Other sources of omission error include the geocenter for which no consensus model is as of yet applied. Although progress has been made in nonconservative force modeling through the use of detailed satellite-specific models, radiation pressure modeling, and atmospheric density modeling remain a potential source of orbit error. The longer term influence of variations in the solar and terrestrial radiation fields over annual and solar cycles remains principally untested. Also the long term variation in optical and thermal properties of the space vehicle surfaces would contribute to biases in the orbital frame if ignored.

We review the status of altimetric precision orbit determination as exemplified by the recent computations undertaken by the different analysis centers for ERS, Envisat, TOPEX/Poseidon, Jason, Cryosat2 and HY2A, and we provide a perspective on the challenges for future missions such as the Jason-3, SENTINEL-3 and SWOT.